

ROYAL SOCIETY EXPEDITION TO NORTH BORNEO 1961: REPORTS

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General Report

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Plates 1-18

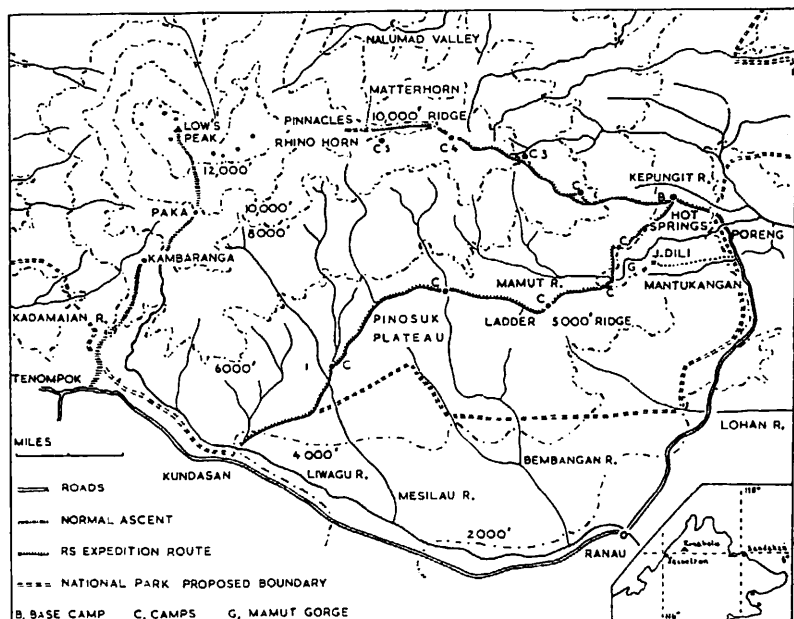
From the beginning of June, until the middle of September, 1961, the Royal Society Expedition explored the east and south slopes of Mount Kinabalu. According to a programme of reconnaissance, which was the main object, we traversed in this steep and heavily forested country, and re-traversed, a course of some 30 miles. At any mile we could have camped for the whole period and been fully occupied with scientific investigation so varied and stupendous is the scenery, so rich the plant and animal life, and so complex their interrelation with the soils. We left a trail that will last for some years. We carry recollections of vistas which opened as we journeyed but time prevented us from pursuing. Others will follow, and the purpose of this account, before the scientific work is complete, is to record for their benefit, while memory is fresh, general observations where there was no previous knowledge.

PREVIOUS EXPEDITIONS

Castellated, clouded, then sunlit, and glittering with refreshed streams, the mountain (13,455 ft. high) presides over the landscape of western North Borneo, beckoning the adventurer. The first historic ascent was in March, 1851, made by Hugh Low, administrator and naturalist, when he was Colonial Treasurer at Labuan. With Spenser St. John, administrator and zoologist, he made two more ascents (April, July, 1858). Inspired by their discoveries of orchids, pitcher plants, and rhododendrons the horticultural firm Messrs Veitch sent their collector F. W. Burbidge who began the despoliation which others

continued in an area of high altitude (c. 4000 ft.) shifting cultivation, as practised by the Dusuns, as the beginning of an enquiry into the problem of natural regeneration.

Then, throughout the journey, the opportunity was to be taken to consider the altitudinal limits which might be advised for the extent of the proposed national park. So much deforestation having occurred on other sides of the mountain, up to 4000 and 5000 ft., the east side might give the opportunity of including in the park an extensive and uninhabited stretch of lowland forest continuous with the mountain forest.



Text fig. 1. Map of the Kinabalu region to show the route of the Royal Society Expedition. (Text-figure reproduced by courtesy of the Empire Forestry Review)

PERSONNEL

The success of the expedition could not be foreseen. It was considered unsuitable, therefore, to organize at this stage a large party to investigate all aspects of botany and zoology. On the other hand it was desired to invite the co-operation of as many scientists as possible from North Borneo and the neighbouring countries of Sarawak, Singapore, and Malaya, where so much of the previous biological record of Kinabalu is stored in the herbaria and museums. In effect, on the zoological side, the small mammals, the birds, the amphibia, and the freshwater fish became the objects of study, and on the botanical side the flowering plants and the higher fungi.

The plan became that of an advance party, consisting of three botanists Dr Chew Wee Lek, A. Stainton, and myself, to establish and victual a series of camps along the east ridge in order that those coming later with more limited time should be able to move with least delay. It was arranged also in Jesselton, in order to arouse youthful interest, that a patrol of boy-scouts should join us for 10 days at the end of July. Then, by means of letters and tape-recordings, the progress of the expedition was transmitted to the Information

Officer, J. M. Dinwiddie, in Jesselton who kept the local press informed and, thereby, the papers in Hongkong, Malay, Singapore, and Sarawak.

To Stainton, with his Himalayan experience, the expedition was indebted for most of the pioneering, the cinematography, and a great deal of the photography.

The main supplies of the expedition were prepared by G. E. Hemmen, at the Royal Society, and despatched by sea through the office of the Crown Agents.

The personnel was as follows:

U.K.—E. J. H. Corner (leader), G. P. Askew (soil-scientist, June 28–September 30), A. Stainton.

Singapore—Professor J. L. Harrison (Nanyang University, zoologist, June 19–July 21), Dr Chew Wee Lek (botanist), Mohamed bin Shah (herbarium-assistant), and Kadim bin Tassim (plant-collector), from the Singapore Botanic Gardens.

Malaya—Professor D. Poore (botanist, July 31–August 15) and B. Ensoll (zoological collector, June 19–July 21), from the University of Malaya.

Sarawak—B. E. Smythies (Conservator of Forests, ornithologist, July 3–July 24), Mrs Collenette (botanist, July 27–August 18), Gaun anak Sureng (Sarawak Museum, zoological collector, July 3–September 6).

North Borneo—Department of Agriculture: E. J. H. Berwick (Director, July 4–11), W. B. Allen (Head of the Soils Division, August 11–28), Chin Phui Kong (Fisheries Officer, June 20–July 3, August 24–28), Chong Yun Fatt (artist, July 4–21, August 24–28), Inus bin Molukin and Quek bin Koka (soil-assistants to G. P. Askew, July 4–September 18). Forest Department: G. L. Carson (Conservator, July 30–August 4), P. F. Burgess (Deputy Conservator, June 1–6, September 7–12), D. I. Nicholson (Forest Ecologist, August 24–September 5), J. Singh (Forest Assistant, June 1–July 18). Peter Lee (Jesselton), leader of the patrol of eight boy-scouts (July 29–August 10).

Special thanks are tendered to the following persons for assistance en route, liaison, and loan of staff: H. M. Burkill (Director, Singapore Botanic Gardens), T. Harrison (Curator, Sarawak Museum), E. J. H. Berwick, W. B. Allen, and G. L. Carson. To Sir George Taylor, Director of the Royal Botanic Gardens, Kew, we were indebted for a great deal of plant-collecting material.

The botanical collections have been deposited with the Royal Botanic Gardens, Kew, where identification and the distributions of duplicates will be arranged. Professor Harrison is dealing with the zoological collections except for the fish and amphibia which are being studied by Chin Phui Kong and Dr R. Inger (Chicago). The soil collections are being studied by G. P. Askew in England. The fungi which I collected are being handled at Cambridge, and the fig-insects are being studied by J. T. Wiebes (Rijksmuseum, Leiden).

THE EASTERN ASCENT ROUTE

From June 2 till July 10 we were largely occupied by the making and victualling of the ascent-route. The narrow jeep-road north from Ranau ends after 10 miles at the Mamut river near the village of Poreng. Here is a government resthouse of bamboo, or rather a halting bungalow, beside the few small hot springs which issue so unexpectedly from the rocks at the foot of the mountain: (temperatures 55–60°C, according to Collenette, and fortunately too hot for mosquitoes). Our baggage, brought by chartered plane and land-rovers from Jesselton to Ranau, was transferred by land-rover from the Ranau Resthouse to this halting bungalow where it was arranged into man-loads for the foot-slogging ascent. Only one slight incident occurred at Ranau. During one night cows came under the rest-house and ate the cardboard cartons of two boxes of tinned fish; next morning we found the tins scattered over the compound but, miraculously, untrampled.

Our supply of Dusun carriers was first engaged through the District Officer of Ranau, J. Dusing Patel, to whose tireless help, advice, and hospitality we were greatly indebted. Later, when the Dusuns came to enjoy the expedition, they fetched their kin from villages

Besides major landslips, large and small rocks keep falling down. The larger smash their way through the forest to a standstill. We continually encountered them at all altitudes and called them 'erratic blocks', some being as much as 30 ft. high. In their wake arise new opportunities for regeneration. Having come to rest, often with an overhanging side, they make a cluster of new habitats in damp shade, dripping walls, and exposed top where epiphytes become saxicolous. According to altitude, again, they have their characteristic vegetation, even their own trees rooting from the top. Thus, between 4000-6000 ft., the slender shrubby *Ficus setiflora* Stapf was generally to be found on these erratic blocks and nowhere else. The smaller rocks, however, may be caught in the branches of trees and care must be taken to watch out for them while clambering in stream-gullies full of things about to topple.

There is an extensive old landslide, fairly heavily covered with regenerating forest, about half a mile south of Base Camp. It affords a fine view of the Mamut gorge and, possibly, access to it from this side, but we had no time to explore.

Camp 2 (6500 ft.). This camp was situated down a very steep slope about 300 ft. below the ridge beside a small stream which flows eventually into the Langanan river. The distance from Base camp was 3½-4 hr. climbing on the ridge-path. Because of the difficulty of access, we used this camp chiefly as an emergency, but Chew studied the tree-flora intensively and Smythies the ornithology, though it is too high for much bird-life. We did a certain amount of clearing to the east in order to let the sun in, because it was a damp site and apt to become very boggy when the stream rose after heavy rain. Apart from the ridge itself, it was the only place where we were able to botanize extensively on the mountain-side at 6000-7000 ft. altitude and it is certainly worthy of more study. We found no other camping site between Base Camp and Camp 3. At 5400 ft. altitude by the ridge there is a small stream which dries up in the absence of rain. Round the camp, on the ridge above, and on the slopes there are more or less dense tangles caused by a small-leaved climbing bamboo (? *Bambusa gibbsiae*) which ascends the trees to 50 ft. high and hangs in festoons. We met this bamboo later at 5000-5500 ft. in the Mamut valley, much to the inconvenience of path-making, and it seems to be characteristic of the mid-altitude 5000-7000 ft. Unfortunately, all specimens were sterile. Except for a common broad-leaved climbing bamboo at 2000-4000 ft. altitude, also sterile, we did not encounter other kinds.

Some 500 ft. above Base Camp the dipterocarp forest ceases and the montane forest of conifers, myrtles, tea-trees (Theaceae), *Drimys*, *Rhododendron*, *Vaccinium*, and the ever-present oaks and laurels begin and carry on with most of their common species to heights of 10,000 ft. and more. Conspicuous are *Podocarpus imbricatus*, *Phyllocladus*, *Leptospermum*, the orange-barked *Tristania*, and *Schima*. *Agathis* occurs, locally frequent, at 4000-5500 ft. They form the mossy forest in the dripping cloud-belt with thick raw humus, trunks and branches thickly covered with moss, liverwort, orchids, and pitcher-plants, small leathery leaves of sclerophyllous appearance, and twisted limbs of elfin-character in exposed places. This altitude introduces so many new features of the environment as increased wind, prolonged mist, diminished light, lower temperature, and cold soil as well as so many new plants that it is not clear whether the climate or the soil conditions are the more effective in establishing the vegetation. Thus the white sandy podsolized soil was emphasized by Miss Gibbs, but it would now seem more likely that the vegetation is in part the cause rather than the result of the soil condition. Askew's chain of soil-pits up the mountain will undoubtedly throw new light on this vexed problem.

Just below 5000 ft. on the ascent-route, rocks outcrop and the path took a steep turn to a knoll where we felled some trees to obtain a view to the east and into the Mamut valley. Around this knoll grew 80-ft. trees of *Agathis*, *Podocarpus neriifolius*, *P. imbricatus*, *Phyllocladus*, and *Ducrodium falciforme*, along with oaks, Sapotaceae, and two species of *Shorea* one apparently new and the other *S. monticola* Ashton. This knoll, which we did not name except as the '5000 ft. look-out', lies about 1½ hours above Base Camp and is an exhilarating place which gives access along its flanks to rich pockets of herbaceous moun-

tain vegetation: unfortunately we had no time to explore these in any detail. The trees of *S. monticola* were in flower. Their cream white crowns could be seen singly or in small scattered groups on the mountain-side and ridges marking exactly the 4000-5000 ft. altitude. Thus we could identify it on the ridge south of the Mamut river, where we subsequently collected material in verification. The species was discovered originally by the Clemens on the west side of Kinabalu and is now known to occur also in Brunei and Sarawak. Together with the apparently new species, it occupies the highest altitude of any member of the dipterocarp family. On a landslip near this knoll I found the only plants (sterile) of *Ficus endospermifolia* and *F. tarennifolia* which I saw on the east side of the mountain, though both are common on the west. At the foot of the knoll, too, occur trees of the new oak-genus *Trigonobalanus* Forman which we later collected at Kundasan.

Shortly above this knoll, the mossy forest assumes its true character with really impenetrable thickets of tough saplings and general undergrowth interlaced with climbers among which the bizarre *Nepenthes lowii* predominates.

Camp 3 (8300 ft.). Proceeding along what we hoped was the main ridge, for as yet we had no view ahead, in the tangle of mossy forest, we caught no sound of running water until this altitude. A steep drop of 100 ft. on the north side then brought us to a small gradual valley where we set up the important, but chilly and draughty, Camp 3, which served as the intermediate depot on the ascent-route. It lay 6 hr. of climbing beyond Base Camp. About 200 yards down from the camp the stream, also a tributary of the Langanan river, plunged in a vertical drop which, because of our onward march, we had no time to explore: such waterfalls and the gullies leading to and from them provide among their rocks many sheltered places where unusual plants occur, for instance, *Impatiens*, *Begonia*, and *Pentaphragma*.

As we saw afterwards from Kundasan, the ridge at Camp 3 catches the tail-ends of the storms and cloud-wrack which drift eastwards from Tenompok. The stream valley plunges eastwards and catches, too, the ends of the storms from the eastern lowland. The forest in the valley was soaked in mist and rain, and the ground, trunks, and limbs were covered in an immense profusion of dripping liverworts, mosses, and lichens. From this altitude onwards, so cold and damp were the evenings, so frequent the soaking of arms and legs in the wet vegetation that we practically gave up bathing, we donned sweaters and 'heavy-duty trousers' over other clothes and slept, thus, in light sleeping-bags. The Dusuns complained also of the cold and wet. We supplied them with two blankets each, cotton pullovers, and gymn-shoes because in the wet moss the soles of their bare feet softened and cracked. Indeed, in clambering among the steep mossy places, clutching wet stems, roots, and rocks, our fingers suffered likewise and we discovered a want in our otherwise copious supplies, namely hand-cream. After 2 weeks at Camp 4 I had to return to Base Camp because my hands were too sore to work; then, in 2 days, they would heal.

Chew investigated the trees round Camp 3 as was his botanical duty, but many were sterile and our knowledge of the vegetation is incomplete. Harrison named the camp 'Kanta Buroi', which is the Dusun for tree-shrew, so abundant were these creatures; they came to eat food which we put for them on cut stumps just beside the working tent. Poore tried to cope with the bryophytes in his short visit, which I had given up because of the intricacy and profusion of their growth.

It was here that Ben Ensoll first drew my attention to some tooth-marks on the bark of a tree, which he recognized as those of rhinoceros, and he pointed out the rotten trunks which they had been eating, as is their wont. When we arrived here, there was abundance of horse-flies which, as he told me, mark the recent presence of large beasts. A brief anecdote will record the skill of this veteran collector, who had accompanied Boden-Kloss's expedition to Kinabalu in 1928. As we sat on a log studying these toothmarks a scurry announced a tree-shrew. One appeared, followed by another, of a kind which had not been trapped. Swiftly raising gun to shoulder, he pointed them through the dense undergrowth, twisting his body through three-quarters of a circle, while I ducked out of the way. Then, as the leader paused momentarily for a jump, the other caught up. There was a

loud report and Ensell fell over backwards in his unbalanced position, but we picked up two dead shrews. He knew exactly what to shoot and when to get two beasts with one shot.

Harrison reported hearing cicadas on a warm evening at Camp 3. At Base Camp their noise, as usual, was deafening, until our ears became accustomed, and, as usual, the succession of their trills told the time of day. Just before sunrise a long screech, which Stainton called the 'electric drill', aroused us. Then, with various alternating screechings of other species, as the day wore on, there came towards sunset the rasping honk and steam-whistles; through the night there was a ringing ting-a-ling until the drill announced the dawn. But, from Camp 2 upwards, there was silence at night except for the croak of a frog, the patter of rain, or the drop of fruits eaten by nocturnal rats. Of bats, we saw only a few at Base Camp.

Camp 4 (9400 ft.). Shortly above Camp 3, about 8500 ft. altitude, where the ridge bears northwards, we had the first glimpse of the summit-dome of rocks. It meant that we had passed the shoulder which separates the Mamut valley from the Bembangan, and on to its precipitous source we now looked. Here and at a few other places we cut down trees to widen the view and to establish look-outs for the ornithologists, Smythies and Berwick, who would follow. I mention these details to record what we did that altered the otherwise natural conditions. The track plunged again into ridge-forest, which varied from 10-30 ft. high, having the taller trees in the wet hollows. Then we came to the first of the two mountain-tops marked 9025 ft. and 9450 ft. on the map. They are covered with ridge-forest, resembling attenuated mossy forest, and to obtain a view we had to climb small trees of *Leptospermum*, *Podocarpus*, and *Phyllocladus*. We could at last see to the summit and north-eastwards to Gunung Tambuyukan. The Dusuns became enthusiastic and, studying the map beneath the outlook tree, put two dead horse-flies on the summit contour to mark the arrival there of their leaders Laminggu and Gelidah (who now styled himself 'orang gunung', or the man of the mountain). They were too optimistic. Nevertheless the horse-flies indicated that we were following animals, though footprints could not be found.

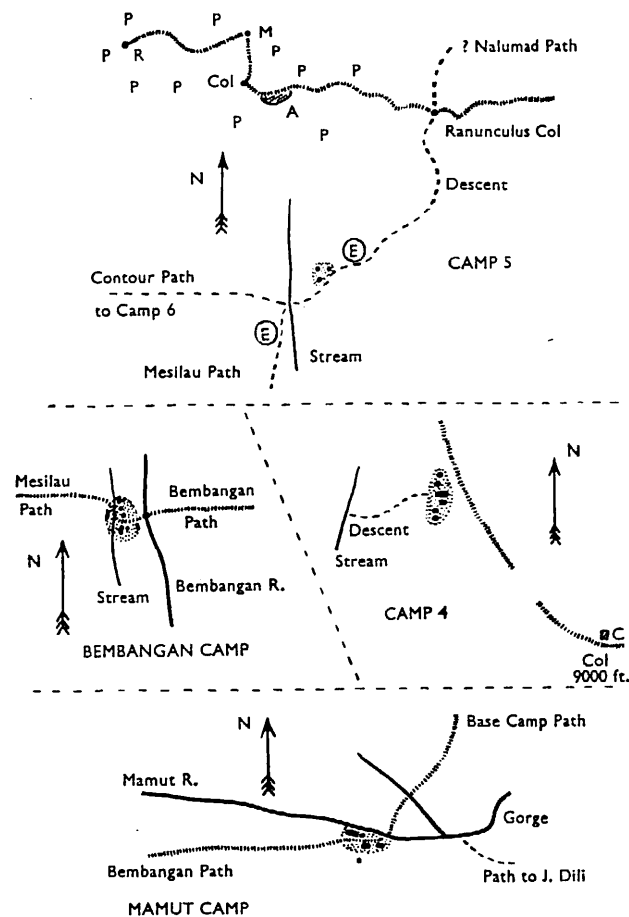
Between the two tops there is a saddle of dense mossy forest but around each top there are many paths made by animals and small open places covered with a thin layer of grasses (*Isachne kinabaluensis* Merr., *I. saxicola* Ridley) with *Patersonia borneensis* Stapf (the Australian Iridaceus genus), *Haloragis micrantha* Br., and the very small *Gentiana lycopodioides* Stapf. Conspicuously fringing these places on dry rocks was the dwarf fern *Gleichenia peltophora* Copel. There were also small, shallow bogs, 6-9 in. deep, in which grew *Sphagnum* and numerous Cyperaceae including *Cladium*. After reaching 8000 ft. or so, *Nepenthes lowii* gave place to quantities of *N. edwardsiana* with long symmetrical pitchers and very strongly ridged peristome.

After the second top there was an annoying descent of 500 ft. to a saddle from which rose steeply the higher ridge marked 10,300 ft. on the map. It was not the distance of which we complained but the toil of any extra labour in the mossy forest. Roots, inclined stems, and fallen trunks, all covered with moss, formed an inextricable tangle over rocks and the wide gaps between them. Many of these had to be spanned by poles lashed together with rattan, of which there was still plenty. Thus we climbed more often on slippery roots, trunks, and poles than on rock, having always to beware pitfalls, and firm ground was a treat. It should be possible to contour round the second top on its north side, but we had no time or labour to spare for this.

Water was found 300 ft. below the saddle on the north side. The descent, as usual, was tiresomely steep and the stream was a poor trickle in a dense glade of the urticaceous shrub *Pilea*; here, however, we met the giant bracken *Pteris wallichiana* Ag., which is a new record for North Borneo. A small camp site was cleared on the saddle, where there was a splendid view to the east, but it was too windy and cold. A better water-supply was discovered a few days later in probing the ascent of the 10,300 ft. ridge. On a short spur in the forest, 200 ft. above the stream which flowed into the Bembangan river, Camp 4 was sited.

It was now the end of June and 20 days had been spent in making the ascent from Base Camp.

Camp 4 became the base for our work during July. It was colder than Camp 3 but not so draughty, though it caught more of the heavy storms from the mountain-top. The arrival



Text fig. 3. Sketches of camps, with notation as in Fig. 2. Camp 4 (grid ref. 418359); C, unused camp site cleared at the col. Camp 5 (grid ref. 398357); E, 'orratic blocks'; M, 'Matterhorn'; P, precipices; R, 'Rhino-horn'. Mamut Camp (grid ref. 472312). Bembangan Camp (grid ref. 418308).

of Harrison and Smythies on July 8 was greeted with a hailstorm. We had four 2-men tents, a small tarpaulin for the stores and working platform, and a large tarpaulin for the Dusuns, who talked through most of the night round a smoky fire and grew more and more en-grimed. The camp lay about 3 hr. walking beyond Camp 3 and, in terms of rice-transport,

at least 3 days of exhausting carrying above the Hot Springs. Thus the supply of the basic ration began to be a problem and we had to organize special rice-lifts to cater for the line of camps.

Camp 4 was in the upper mossy forest. The trees were mostly 20–30 ft. high but, in the gullies, they grew to 70 ft. Fairly common and conspicuous from its massive trunk and large leaves was a species of *Talauma* (Magnoliaceae). To collect the fruits of this we had to fell a tree with a trunk 2 ft. in diameter, which required 3 hr. of axing; we tried to avoid felling, but here trunks were too wet and slippery to climb. Conspicuous in the undergrowth were rubiaceae shrubs and small trees, all with characteristic manner of branching of the main stem. They fruit on the side-branches which are collected for the herbarium-specimens, and botanists too frequently ignore the main stem which provides such useful field-characters. The quantity, size, and variety of ferns in the stream-gullies at this altitude was truly staggering.

At 9700 ft., above Camp 4, the yellowish clay soil and the mossy forest with its thickets of rattan gave place suddenly to granite out-crops and an oakwood composed mainly of the high Bornean oak *Lithocarpus havilandii* (Stapf). This species was first collected on Kinabalu by Haviland but has since been found in Sarawak. The vegetation, which had been rather similar from 6000 ft. upwards, now changed abruptly and we were able to walk about freely round and over the rocks and the leaning trunks. I found a good way to collect by climbing out on the leaning trunks and gathering from the crowns of smaller trees which grew up to them from lower down the steep slope. *Eugenia*, *Ilex*, *Eurya*, *Symplocos*, and *Polyosma* were common. On the ground was a thick array of slowly rotting, fallen trunks, branches and twigs, and underfoot the dark-coloured and strongly acid soil abounded in earthworms. Their castings were often formed into large turret-shaped mounds some 8 in. high. The rapid incorporation of litter into the mineral soil by these worms prevented the build-up of a thick humus layer as in the mossy forest. The oak-trees leant and twisted until they became prostrate, when they threw up new limbs, as if they could not die. Animal life seemed scarce except for the Mountain Blackbird (*Turdus poliocephalus seebohmi*), so tame and ignorant of men, as all visitors to the mountain have noticed, that it sits like a giant robin with plum-coloured vest almost within arm's reach. The birds hopped around me as I turned over the logs in search of fungus and mistook me, I am sure, for a rhinoceros.

This change in vegetation needs, nevertheless, fuller investigation because it seems to occur at a higher altitude than the significant soil-change. Thus, according to the very extensive series of soil-pits which Askew made up this incline from Camp 4, the sandstone of the pits at and below Camp 4 gave place shortly above 9400 ft. entirely to granite.

About 100 ft. below the crest of the 10,000 ft. ridge, there is on the south side a broad ledge, 100 yards wide or more, where the coniferous-myrtaceous forest reappears with more frequent and larger grassy glades and shallow sphagnum-bogs. Here Ensoll found footprints of the rhinoceros and abundant evidence of their browsing. He discovered, too, why the oak-wood was so comparatively easy to move about in. It was worked into narrow corridors and ledges by the passage of large beasts twisting and winding round the rocks and trees. Rhinoceros, wild cattle, sambar deer, and pig certainly frequented the high ridge. The horse-flies, again, proved that our arrival had driven them onward. To see them, of course, needs lone tracking. Our van of path-cutters would have disturbed them. Ensoll, in spite of his sixty years, made many lone clambers along the ridge-side, but was unsuccessful in seeing them. There can be no doubt, however, that on this 10,000 ft. ridge, a few rhinoceros find a mountain refuge which connects with the undisturbed Pinosuk Plateau to the south and the precipitous Nalumad valley to the north, whence they may still have a mountain route to the Mount Templer Reserve. Here is a place where the lingering ecology of the Sumatran rhinoceros should be undertaken. One would like to know what it lives on, whether its coming and going are connected with the fruiting of trees and the quick growth of the myriad seedlings, where it may breed, and how it spends the time of almost incessant

rain from October to December when the ridge would be inhospitable enough for the woolly rhinoceros. Shade-temperatures on the ridge at 10,300 ft. ranged from 3–4 °C (minimum) to 18–24 °C (maximum) according as the sun shone. At Camp 4, in the forest, these temperatures were 3.5–6.7 °C and 13–19 °C.

Near the crest of the ridge the forest dwarfs, and one bursts with delight on to a stupendous view. *Podocarpus imbricatus*, *Phyllocladus*, *Leptospermum*, *Ilex*, *Symplocos*, *Rhododendron*, and *Vaccinium* become waist-high shrubs, intermingled with orchids, several species of *Lycopodium*, *Euphrasia*, and the dwarf *Nepenthes villosa* in place of *N. edwardsiana*. If it is still before 9 a.m., and the clouds have not gathered, the north tip of Borneo may be seen. Eastwards there is a suspicion of Sandakan. Southwards over the Pinosuk Plateau there is range after range of forest-clad mountains to the Indonesian distance. Westwards, and deceptively close, is the rocky dome of Kinabalu from which the jagged north ridge runs to Gunung Nonoh and walls in the unbelievably steep and precipitous upper reaches of the Kinapasan and Nalumad rivers. Along this ridge we worked during July. We had no name for it, other than the 10,000 ft. ridge.

Camp 5 (9500 ft.). According to the map this ridge has gentle contours. There are nevertheless numerous ups and downs, where mossy forest with glades of grass, sedge, fern, and orchid reappear in the boggy hollows, and it ends, so far as a path is concerned, in pinnacles, giant rocks emergent from the forest, and a ring of precipices, none of which is marked: it does not give access to the eastern peaks of Kinabalu.

Two and a half hours' walking along the ridge, with much scrambling, brought us to a col at 10,200 ft., there we found plants of *Ranunculus lowii* Stapf, or a close ally. The mossy forest descended steeply on either side and, as above Camp 4, soon passed into oak-forest. We probed both descents and found a stream and comfortably adjacent camp site on the south side 700 ft. below the col, still in the Bembangan watershed. This col must be known to the Dusuns for we found a narrow track leading down from the camp site to the Mesilau river, but the 10,000 ft. ridge certainly had no man-made path until we arrived. There may be a track via the col over to Nalumad valley, or village, if there be one, on the north of the east ridge.

Camp 5 was dismal and gloomy. We had no time or labour to clear the site. Tentage was short and our Dusuns sheltered under the overhanging sides of a group of large 'erratic blocks'. Fires were made with difficulty because of the prevailing wetness and plant collections were despatched daily to Camp 3, where plant-drying was completed. Listening to the drips, as I lay there on my camp-bed the first night, I heard continued drops which awoke in my memory a sound of Malaya. Small hard things fell and rolled. Next morning I verified my guess that they were the fruits of *Adinandra*-trees (Theaceae) partly eaten by nocturnal rats. There were two species, which have been identified as *A. impressa* Kobuski and *A. verrucosa* Stapf. One had reddish pink flowers, the other deep crimson. Eight species are known from Kinabalu, according to Kobuski's monograph, but it is clear that we know little about their ecology, flower-colour, pollination, and dispersal. In Malaya I knew them as having cream-white and, possibly, bat-pollinated flowers and bat-distributed fruits. In Malaya, too, several species for this reason of distribution distinguish secondary forest. Thus, I discovered that Camp 5 was pitched in old, extremely dense, secondary forest of *Adinandra* on a large scree which had, in fact, been the cause of the difficulty of fixing up the tent the day before. From the height of the trees (50–60 ft.), the thickness of the trunks, and the evenness of the stand, I estimated its age at 70 yr. Ascending to the ridge again I saw about 300 ft. above the camp the rock-face from which had clearly fallen the avalanche which had smashed the original oak-forest (*L. havilandii*) and permitted the invasion of *Adinandra*. Small trees of *L. havilandii* were beginning to re-establish themselves in this secondary forest which will revert, presumably, again to oak-forest. Below Camp 5 there were many more immense 'erratic blocks', the overhanging sides of one of which could have sheltered about two dozen people. Here were the remains of a recent camp-fire, and the track to the Mesilau lead past this block. We hoped that it was not used for hunting

rhinoceros. Small plants of *Galium*, *Alternanthera*, and some composite grew round the 'block' and their adhesive fruits may have been carried up by the travellers from the Mesilau river, for we found these plants frequently along the more open rocky banks of the rivers of the Pinosuk Plateau. We followed the track down several hundred feet to the divide between the Bembangan and Mesilau watersheds. It continued into the Mesilau valley across which we saw a magnificent oak-forest of *L. havilandii*, which is easily recognizable from the fawn-brown young leaves, and somewhere in this forest, which we had not time to reach, tumbled a waterfall the roar of which filled the air.

Proceeding westwards along the ridge from 'Ranunculus col' above Camp 5, we found that it became more rocky, broken, and precipitous. At 10,600 ft. there was a long, sloping rock rather thinly clad with bushes and orchids, but becoming bare on its northern edge where it made a precipice, a 100 yards or so in length. On this rock I found a fruiting bush, 6 ft. high, of *Ficus deltoidea* var. *intermedia* (*F. kinabaluensis* Stapf), which provides the highest altitudinal record of the whole genus. From the precipitous edge we studied the composition of the gully forest which lead down into the Nalumad valley. Predominant in the canopy were trees of *Talauma*, *Schima*, *Photinia*, *Ilex*, *Eugenia* (2 spp.), *Symplocos buxifolia*, *Podocarpus imbricatus*, *Phyllocladus*, and *Leptospermum*, with a few spindly trees of the euphorbiaceous *Daphniphyllum borneense* Stapf.

Shortly beyond this rock rose what appears from the east to be the first pinnacle. Smythies had spied it from a rock near Ranunculus col and, from its shape, called it the 'Matterhorn'. It is the broken east end of the short step-up in the ridge, as seen from Kundasan and Ranau, which leads to the Rhino-horn. Our Dusuns assured us that they knew this point as Gunung Mayabau, and, thus, confirmed my suspicion that there was a track from the Mesilau river over the ridge to Nalumad. I do not think, however, that there was any previous path to the 'Matterhorn', for there were no signs of a track, just as on the 10,000 ft. ridge east of Ranunculus col.

To scale the 'Matterhorn' was possible only through the dense scrubby forest on its south side. To make the path up the 500 ft. to the top occupied our five leading Dusuns for 3 days. It was so steep and involved so much climbing by roots ('gardening', as Stainton informed me, was the Himalayan expression) that, as leader of the expedition, I declined responsibility for any who ascended. At the top there was the same superb view, yet grander from the proximity of the granite dome of Kinabalu. We scanned through the telescope the means of further ascent and decided that it should be possible by various detours to the southern side of the pinnacle-region, the northern being clearly too precipitous. Alas! Half a mile beyond, in very broken scrubby forest with trees 10-20 ft. high and emergent rocks everywhere, we reached the obelisk-like pinnacle about 200 ft. high which we called the Rhino-horn from its shape and its emblematic mark of the beasts. Around this pinnacle to north, west, and south were precipices which stopped progress. Returning from this point on the first occasion, we encountered such a fierce north-east wind and cold rain that our fingers became numbed and we had considerable difficulty in hanging on to the rocks and tried to prevent us from being blown off or from falling into the numerous crevices.

The Rhino-horn having ended the ridge-path, we began a contour from Camp 5 at 9300 ft. I had to decide, however, in view of the rest of our programme (for it was now the second half of July), the difficulty with tentage and rice-supply, the coming of the major festival of the year at Ranau on July 24 which would deprive us for a few days of most labour, and the uncertainty of reaching a new biological region, that we must call a halt. Later, in early August, nevertheless, Askew was able by the contour-route to make a sixth camp.

Between the Rhino-horn and the summit-dome of Kinabalu lies the main region of pinnacles where granite spires outcrop similar to the 'Matterhorn', yet larger. To reach this region an expedition should start from Kundasan whence in 2 days it could arrive at the col to the west of the Rhino-horn, and the long supply-line up the east ridge would be unnecessary.

The pinnacles are, like the Rhino-horn and the 'Matterhorn', denuded and weathered fingers of the intrusive granite which raised the mountain. The summit of the 'Matterhorn' still has in rock-crevices pockets of residual soil which support a few dwarfed and relic shrubs of *Leptospermum*, *Schima*, and *Rhododendron ericoides*, with a grass, an *Eria*, and two kinds of fern. Thus I identified them through the telescope because I would not allow anyone to scale the last 20 or 30 ft.; it meant a jump on to a rock-slope without obvious hold with precipices on both sides. Formerly, I suppose, the 'Matterhorn' was covered soil and forest in the same way as the eastern end of the 10,000 ft. ridge where, indeed, the granite is becoming exposed and may eventually give a second 'Matterhorn' to be seen from the 9450 ft. top. Similarly I suppose that the pinnacle-region was forested and I extend the argument to the bare summit-dome itself, but what vegetation may then have covered it and whether it was a snow-mountain are conjectural. The pinnacle-region reveals how the mountain is wearing and breaking down. It may harbour patches of former summit-vegetation and, until it has been explored, our knowledge of the high-altitude flora of the mountain will be incomplete.

The scree about Camp 5 is a small instance of the vast number of rock-falls from the denuding upper regions which have accumulated in the south-east bay of the mountain to build up the Pinosuk Plateau. The whole sequence of vegetation about the altitude of Camp 5 seems to begin with grasses, sedges, ground-orchids, *Gleichenia*, *Lycopodium*, and, possibly, the tall moss *Dawsonia*. Then invade the trees of *Adinandra* and the high altitude rattans, to be followed by oak-forest of *L. havilandii* or, at least in the gullies, the forest of *Talauma*, *Eugenia*, *Symplocos* and the conifers. An expedition based on the Pinosuk Plateau could study these intriguing successions.

A feature of the high ridge vegetation in need of further study is the presence of the comparatively open glades. Under scattered trees they have a ground-flora of grasses, sedges, ferns, and orchids. They develop, it seems, in ill-drained hollows, for sphagnum occurs where the water stands after rain, but it is possible that they are maintained and enlarged by the herbivorous animals which frequent the ridge. I wondered if they might not be the secluded place where the young were born. Askew found similar glades on the sloping ridge-sides, not in the hollows, on the path to Camp 6.

Near Ranunculus col we found a fallen nest of the Mountain Black Eye (*Chlorocharis e. emiliae*). It was made, as Allen and Berwick have described (1958), from the aerial roots of an orchid, and lined thickly and softly with the golden stalks of the capsules of a species of moss. Smythies and I searched for the moss (as yet unidentified), but not till a fortnight later did I discover it by chance on the underside of a leaning rock where neither rain nor drips nor trickles could wet it. Thus the little bird knows where to gather the one dry lining in the region of mist.

On July 23, we left Askew and his assistants Inus and Quek at Camp 4 and descended to Base Camp for the next journey over the Pinosuk Plateau. My impression of the mountain falls into eight parts.

1. The steep west face, which has been extensively explored but cannot be said to have been studied ecologically.
2. The bare summit and pinnacles, to which the same remarks apply.
3. The long north ridge to G. Nonohan (10,000 ft.). This ridge is unexplored, so I believe, and is higher and more jagged than the east ridge. After studying it through the telescope, I am sure that it offers many different features. There should be lowland access to it from Nalumad which separates the two main arms of the Kinapasan river. It seemed possible also to follow the north ridge on its east side some distance below the top, which would be too jagged. Thus, the eastern summit of the mountain may be reached.
4. The east ridge, which we ascended, is peculiar in the very extended zonation of the mountain vegetation. Thus, the three zones of *Nepenthes lowii* (5500-8500 ft.), *N. edward-siana* (8000-9500 ft.), and *N. villosa* (9500-11,000 ft.) continue each for several miles along the ascent. It is not certain, also, whether the oak-forests of *Lithocarpus havilandii* occur

and into the new problem, briefly encountered on the way to the Mamut river, of thorny palms (? *Zalacca*, but sterile). The abundance of *Adinandra* in many of these parts indicated that they were old landslips. After slashing at these for 2 or 3 days our Dusuns wearied and struck uphill, where we got into a maze of small ridges but here, fortunately, the map was accurate and we found the way, against our intention, on to the 5000 ft. ridge which is the southern rampart of the Mamut valley.

We made a temporary camp at 4500 ft., halfway along the mid-valley of the Mamut, which we called Agathis-camp from the numerous, large, untapped trees of this genus. Here was a common small lauraceous tree (sterile), which I had not seen elsewhere, and I regret that ceaseless rain on August 14, when I moved to Agathis-camp, prevented me from exploring this interesting neighbourhood.

Stainton was now a day's march ahead with the path-makers who, left to themselves, were lost. Dusuns are good at following ridges or streams, but cross-country journeys seem to confound them: the use of compass, altimeter, and map is, of course, unknown. I followed with the baggage and the main body of carriers who were beginning to murmur. Food was not plentiful and we were all tired of the chilly wetness. Several carriers wanted to return home. For the first and only time on the expedition I was compelled to rule that, if a man left without a substitute (several of whom we were expecting), he would lose wages for as many days as we were without the substitute. We had explained to the Dusuns before starting on the Pinosuk journey that, as we should be cut off in the forest, we expected all who came to stay with us for the whole journey. They rallied except one who struggled with himself before us for half an hour until, urged by his friends and by Gaun who was with me, he picked up the load which the others had assigned to him (and it was the heaviest!), and followed. That morning I had told our Dusun marksman, Rassid, to shoot a pig; and the sight of the great carcass by the path later in the day solved all the immediate problems of labour.

At its western end, the 5000 ft. ridge is a knife-edge covered with typical mountain mossy-ridge forest. Looking south through the trees I saw nothing but another maze of ridges, all clad in heavy forest, where it would be very easy to get lost, and I understood the dislike of the cross-country route. The knife-edge curved north and, as I expected, stopped with a small precipice. Our van had built a ladder of tree-trunks 30 ft. long by which we descended on to the broad divide leading to the Bembangan valley. At this point the photographic film in my camera stuck. Though I had put it in the camera only 2 days before and had kept the camera at night in a drying bag of polythene, the high humidity had glued up the film and I could take no photographs of this end of the Mamut valley.

The map shows correctly the very gradual nature of the broad divide between the Mamut and the Bembangan (misspelt Berambang on the map). I came back to explore it 2 days later. It is ill-drained and swampy with much sedge and climbing pandan (*Freyinetia*), and many small sphagnum bogs. The forest, 20–40 ft. high, consists mainly of gnarled, moss-covered, and small-leaved trees dominant among which are all the common trees of the mossy forest of the 5000–7000 ft. ridges. Thus, *Agathis*, *Phyllocladus*, *Podocarpus imbricatus*, *Dacrydium falcoforme*, and *Leptospermum* were abundant, but the orange-barked *Tristania* was superseded by another common *Tristania* distinguished by its dark greyish brown, cracked and fissured, rugged bark with no tendency to peel in scrolls. There were also various small-leaved oaks, chestnuts, laurels, and species of *Eugenia*. This forest we found repeatedly on broad divides between the rivers of the Pinosuk Plateau and, as a great expansion of mossy ridge-forest, it is the cause of the gloomy, small-crowned and fine-leaved appearance of the Plateau from a distance. Yet, where this formation is interrupted by the rivers, much better forest with trees up to 100 ft. high develops on the steep, rocky, well-drained descents which lead to them. On such declivities at 5000 ft. the orange-barked *Tristania* is again among the commonest and largest trees, and it is accompanied by taller, large-leaved oaks, Lauraceae, Meliaceae, Sapotaceae, and genera such as *Garcinia* and *Diospyros* of which *D. britannoborneensis* was a fairly frequent monopodial tree, to

100 ft. high. Lack of drainage seemed to be the chief cause of the poor nature of much of the forest on the plateau. Unfortunately we made no soil-studies because Askew was still completing his high altitude work on the east ridge.

Bordering the east flank of the Bembangan river at 5500 ft. is a narrow ridge running north and south, and from this dropped the steep descent of 300 ft. to the river, smaller here than the Mamut but tumbling a very broken course over large rocks.

Bembangan Camp (5200 ft.). The camp was pitched on a small river-terrace on the west bank. We cleared the site of small trees to let in the sunlight and to provide firewood for cooking and plant-drying. The green wood of the orange-barked *Tristania* burns well once a fire has been started. After 2 weeks in sodden forest where clothes, towels, and blankets smelt mouldy, for they could not be dried, we were favoured with a week of fine weather. The strong wind, called by the Dusun *kumaru*, sprang up and blew day and night. We stayed 7 days at this camp during which we alternately visited the path-cutters to direct them on the contour to the Mesilau river, and explored the neighbourhood. The forest was dense and varied. Flat places were swampy and full of rattans and the *Zalacca*-like palm, much to the delay of the path-cutters who could progress through these thickets merely a few hundred yards a day. The forest on slopes, marked by the orange-barked *Tristania*, interlaced with that marked by the rugged bark *Tristania* in the wetter peaty places. Just north of the camp was a steep rise covered with a dense stand in which a species of *Casuarina* (unfortunately sterile), predominated. It was the only place during the expedition where we met *Casuarina*. I had noted it on the Bembangan river through the telescope when scanning the Pinosuk Plateau from the 10,000 ft. ridge. On the opposite side of the river was a landslip in the stage of recolonization by grasses, sedges, *Cladium*, a dwarf pandanus with solitary round fruit forming low thickets, orchids (including *Cyrtipedium*), and young trees here and there of the orange-barked *Tristania*, the *Casuarina*, and *Myrica*, but no *Nepenthes*. We had noticed from the east ridge many interesting features of the Bembangan river, between 6000 and 8000 ft., particularly where it flowed leisurely in deep pools between broad flat rocks, but we failed to reach this spot on account of the dense, rough going. It was here, also, that I first met in quantity the geocarpic fig *F. treubii*, which we later found to be common by the Mesilau river. We had little time, however, to study the big trees, most of which were neither flowering nor fruiting, but we felled a lauraceous tree of 100 ft. in height, which was common and has proved to be a new species of *Notaphoebe*. An interesting record was a single 80 ft. tree of *Macaranga javanica* in the dense forest at 5600 ft.: this species is generally considered to be a common and rather small tree of secondary growth, and this lone specimen shows its rare natural occurrence in forest. In gravel by the river grew the *Galium* which we had seen at Camp 5 and small *Viola serpens* Wall. with white scentless flowers faintly striped violet.

Game abounded round the Bembangan camp and all along the route over the plateau. The barking deer were heard in the morning and gibbons in the trees. Pig-tracks and litter-beds were everywhere. There were footprints of sambar deer, and claw-marks of what we took to be civet-cats on the tree-trunks. But we saw no nests of orang-utan and remarkably few birds. It seemed just such a place where the rhinoceros would come. A hunter's track went up the Bembangan and another the Mesilau to connect, presumably, with that at Camp 5 on the ridge, but no human tracks crossed the undisturbed forest of the plateau.

Mesilau Camp (5000 ft.). On August 21 a rather leisurely walk of 5 hr. over gradual country brought us to the Mesilau river where on a very narrow terrace we built a very makeshift and final camp. The forest through which we passed resembled that round the Bembangan river but every here and there were clusters of fine *Agathis* trees, untapped as the whole region seemed to us unexplored. There was little flowering and the undergrowth presented a dense monotonous appearance of small-leaved sclerophyllos plants among which was a broad-leaved *Ternstroemia* simulating *Rhododendron lowii* of higher altitudes. Every here and there were 'erratic blocks' on which we were sure to find an interesting plant.